Studies in Educational Evaluation 44 (2015) 9–15

Contents lists available at ScienceDirect

Studies in Educational Evaluation

journal homepage: www.elsevier.com/stueduc

Cognitive learning in authentic environments in relation to green attitude preferences

Christian Fremerey *, Franz X. Bogner

Z-MNU (Centre of Mathematics & Science Education), Department of Biology Education, University of Bayreuth, Germany

ARTICLE INFO

Article history:
Received 7 July 2014
Received in revised form 30 September 2014
Accepted 16 November 2014
Available online 6 December 2014

Keywords:
Authentic learning
Drinking water
2-MEV
Preservation and Utilisation
Cognitive knowledge
Semantic differential

ABSTRACT

Authentic activities in school are rare although they probably lead to longer lasting learning. In our study, 185 fifth to seventh graders participated in an out-of-classroom lesson at a major water supply institution. After an introductory film presentation, participants proceeded to authentic learning sites with the major machinery involved in water purification. We monitored participants' environmental attitudes (using 2-MEV scale), newly acquired knowledge, and responses to semantic-differential-items. While knowledge and the value of Preservation correlated significantly with cognitive learning achievement levels, the one of (exploitative) Utilisation did not, neither short- nor long-term. Selected semantic-differential-items such as 'easy to understand' and 'motivating' showed positive correlation with acquired knowledge levels. The relevance for school is discussed.

Introduction

Clean drinking water is an indispensable basis for our living and that is why state authorities provide a continuous review of drinking water supplies, following the national and European Community directive for drinking water (BBGU, 2011 (report of the federal ministry of health and the federal environmental agency); Grummt, 2007). The directive sets out parameters for drinking water defining detailed requirements, especially at the extraction points with their subsequent control mechanism. A regular testing scheme provides the basis for the excellent water quality in most developed countries (Bartel et al., 2010; BBGU, 2011; Doria, Pidgeon, & Hunter, 2009). However, the resource water continuously needs to be protected by everyone. Therefore, nationwide educational efforts are necessary. For supporting this goal, authentic outreach sites are regarded as appropriate information and coaching sites.

Lake Constance Water Supply, as the largest water supplier in Germany, follows a communication policy of openness including guided tours for the general public. This opportunity includes educational activities to school groups offering authentic environments and access to selected supply sources. Two full-time educators manage the intricate educational programme. The purpose is to cognitively inform participants about the institutional work in specific and the importance to protect the resource water in general. The aim of our paper is to investigate the effect of this short-term authentic learning programme on cognitive achievement and the relationship between knowledge and green attitude preferences.

The integration of working life experience is an integral goal of school education as well. A popular way to provide it, are for instance guided factory tours (Kaibel, Auwärter, & Kravcik, 2006). Due to tight school schedules one-day educational modules are more likely as well as they match the school curriculum better (Sellmann & Bogner, 2013). Short-term authentic learning environments provide additional values compared to classroom lessons (e.g., Scharfenberg & Bogner, 2013; Herrington & Oliver, 2000). The latter described authentic learning environments as a vivid connection to reality which may substantially support cognitive learning. Such out-of-classroom lessons may offer first-hand experience and assist pupils to better understand the content (Stein, Isaacs, & Andrews, 2004). In authentic learning environments "participants see, hear, smell and feel their environment" (Kaibel et al., 2006; p. 203). Knowledge is presented in different ways as it is in line for instance with Mayer (2001) who sees in multimedia learning the major advantage of acquiring

* Corresponding author at permanent address: Universität Bayreuth, Didaktik der Biologie, Universitätsstraße 30, 95447 Bayreuth, Germany. Tel.: +49 0921 55 3928; fax: +49 0921 55 2696.
E-mail address: Christian.Fremerey@uni-bayreuth.de (C. Fremerey).

http://dx.doi.org/10.1016/j.stueduc.2014.11.002
0191-491X/

cognitive knowledge via different channels. In line with more recent studies (e.g., Pöhnl & Bogner, 2013; Holzinger, Kickmeier-Rust, Wassertheurer, & Hessinger, 2009), a multimedia learning inclusion into learning modules is expected to produce a higher learning success. Especially in green environments authentic experiences often affect individual environmental perception levels (Johnson & Manoli, 2010) and last longer (Liddicoat & Krasny, 2014). Kaiser, Roczen, and Bogner (2008) showed in their empirical model that knowledge and environmental attitudes play an important role to reach an individual behaviour level. One-day environmental education programmes, however, in general, are not expected to affect attitude or behaviour, but regularly may show significant positive effects on knowledge (e.g., Bogner, 1998). Nevertheless, the main purpose of one-day interventions is to acquire new knowledge as well, because acquisition of knowledge is an essential indicator for educational success. Outdoor experiences have positive effects and contribute to cognitive development (Backman & Crompton, 1984). This is in line with more recent literature: Fancovicova and Prokop (2011) compared an outdoor learning group with a classroom control group. The topic of both interventions was plants. Pupils in the outdoor intervention yielded higher knowledge scores which remained constant even after three months. Sellmann and Bogner (2012) showed for a one-day educational intervention in a botanical garden a positive cognitive learning effect as well: An even higher achievement is possible, if the intervention is embedded into teaching units before and after. Kossack and Bogner (2012) additionally reported for one-day educational programmes high motivation scores like Herrington and Oliver (2000) did for authentic environments. Therefore, one-day educational programmes offer potential, especially in view of existing realities in classroom schedules.

Until the mid-1990s, there was a dearth of established psychometric instruments for monitoring adolescent environmental awareness, especially when requesting conventional psychometric standards (e.g., Leeming, Dwyer, Porter, & Cobern, 1993). Bogner and Wilhelm (1996) first employed age-appropriate items to capture as many facets of adolescent environmental awareness as possible, presenting a pilot questionnaire consisting of about 70 items, which due to time constraints in outreach sites was difficult to administer. After subsequent studies had applied the scale in different European countries, a bipolar higher-order structure based on a 20-item instrument was extracted and labelled 2-MEV (2-Major Environmental Values) (Wiseman & Bogner, 2003; Bogner & Wiseman, 1999, 2002, 2006). This two-dimensional structure provides the potential to determine preferences in both environmental Preservation as well as Utilisation (Wiseman & Bogner, 2003), which are the two higher order factors of the model. High scores in Preservation signal a positive preference in environmental attitudes and conservation. High scorers in Utilisation are more likely to prefer using/exploiting nature than conservation. Subsequent studies of independent research groups have retested and confirmed the hypothesised dichotomous 2-MEV model of Bogner and Wiseman (1999) with samples from New Zealand (Milfont & Duckitt, 2004), the US (Johnson & Manoli, 2008, 2010) and Belgium (Boeve-de Pauw & Van Petegem, 2010, 2011). Therefore, the 2-MEV is considered to be a reliable and valid measurement tool for the determination of green attitude preferences. In general, a gender difference appeared showing girls as more engaged in environmental protection (Bogner & Wilhelm, 1996; Bogner & Wiseman, 2006). Similarly, Wiseman, Wilson, and Bogner (2012) reported female respondents as yielding significantly higher mean scores on Preservation; in contrast, boys tend to score higher on Utilisation. The objectives of our present study were twofold: First, we focused on cognitive knowledge acquisition during an authentic water supply module and, second, we monitored potential differences in attitudinal extreme groups. Specifically, we focused on (a) cognitive learning potential as well as (b) on potential correlations between knowledge increase and environmental attitude preferences, which we expected unchanged by our short-term intervention and (c) potential correlations between knowledge increase and the individual statements on selected semantic differential preferences. With the selected semantic differential we intend to test whether personal feelings are important for learning in an environmental programme.

Methods

A sample of 185 fifth to seventh graders (average age of 11.7 year; $SD = 0.85$) participated in our study using a pre-/post-test design. 47% were females. The gender ratio was balanced and none of the pre-scores produced gender-dependent significant differences. Our sample came from eight different classes from five different locations in the state of Baden-Württemberg (Germany). Despite of the age imbalance, no significant differences in knowledge between younger and older pupils were found. A paper-and-pencil-test with 10 closed questions on the topics of drinking water, supply of water, and the water supply institution was applied (Table 1). We opted for a specific knowledge questionnaire as our intervention was a content specific one (cf. Pöhnl & Bogner, 2013 or Sellmann & Bogner, 2012). Each question consisted of four multiple choice items, of which only one was correct. The knowledge-questionnaire was completed three times: The pre-test two weeks before the intervention, the post-test directly after the intervention and the retention test about six weeks later. Additionally, during participation all participants responded to semantic differential items, immediately after module completion. Four statements needed response, whether the activity was: Clear or not clear, essential or ineffectual, easy to understand or difficult to understand, more motivating or not motivating.

The 2-MEV scale is designed to measure two orthogonal aspects of environmental values: Preservation and Utilisation (Wiseman & Bogner, 2003; Bogner & Wiseman, 1999, 2002, 2006). This scale has a high validity and objectivity and has been independently confirmed by several research groups. For specific water related attitudes, there is no sufficient scale available and, in this present study, we opted for the multiply confirmed MEV-scale rather then developing a new ad-hoc scale. For this reason, we choose to use a general measure for attitudes. The environmental attitude set (the 2-MEV) was completed before our intervention, thus the scores of each participants could connected to each learning score.

A control group of 34 pupils (of similar age group and educational level) completed the same multiple-choice tests as the treatment group, but without participation in our intervention.

The Lake Constance Water Supply company represents the largest national drinking water supplier (BWV, 2012). Lake Constance is 63 km in length, 14 km in width, with an area of 536 m^2 on the border of Germany, Switzerland and Austria; it contains approximately 50,000 million m^3 of water and is the largest drinking water reservoir in Europe (BWV, 2012). Regular sample analyses always showed scores below the strict threshold limits of drinking water standards (Drinking Water Ordinance, 2001): Low nitrate content of 4.5 mg per litre (threshold limit: 50 mg/l) and a very low phosphate content of <0.0025 mg per litre (threshold limit: 6.75 mg/l) (BWV, 2012; Drinking Water Ordinance, 2001). Due to strict legislation protection measures, most German water supply institutions need just a few steps to produce high quality levels. Extraction methods vary and rely on, for example, sand layers, micro- or activated carbon filters, disinfection procedures with